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STEAM GENERATOR THERMAL VENTING

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is generally drawn to methods of sludge removal from steam generator / boiler tubes and more particularly to an improved method for removing sludge deposits from steam generator / boiler tube support plates using a combination of thermal stress and intermittent pressure pulses.

2. Description of the Prior Art

Deposits and sludge accumulation in boilers can result in four major problems:

1. Accelerated corrosion of the tube support plates leading to crevice blockage, pitting that can lead to tube failure and possibly tube deformation. This phenomenon, known as "denting", can eventually lead to tube cracking.
2. Disruptions in steam/water leading to a reduction in electrical output flow from the accumulation of corrosion products in flow areas.
3. Decreased heat transfer efficiency of the steam generators leading to a reduction in electrical output from deposition of the sludge constituents on the outer tube diameter and/or tube sheet.
4. In Recirculating Steam Generators, sludge piles are particularly common in areas of the generators at the top of the tubesheet with low flow dynamics known as the "kidney regions". Often these sludge piles can include particularly non-porous deposits known as "collars." Collars are

thought to form through the following generalized mechanism. When the sludge depth is less than 0.25 inches thick, bulk liquid penetrates the porous sludge down to the tube and/or tubesheet surfaces and flushes potentially harmful chemical species from the pores. As the sludge pile deepens, perhaps to as little as 0.25 to 0.4 inches, bulk liquid can no longer penetrate the sludge leaving the chemical species to concentrate and solidify into collars.

Many well-documented techniques have been developed to remove corrosion products from steam generators. These techniques may be classified as either chemical or mechanical methods. Chemical methods have been utilized for over 30 years and involve application of chemical cleaning solvents in a sequence specifically determined for each plant based on deposit composition. Mechanical methods include high-pressure nitrogen injection and water lancing.

High-pressure nitrogen injection is known by several names: Water Slap when applied by Babcock & Wilcox (B&W) or Framatome ANP, Inc., Hydro Impact Cleaning Process when used by Ontario Hydro and Pressure Pulse Cleaning in a similar process employed by Westinghouse. The technique involves pulse-injecting large volumes of nitrogen at high pressure into the steam generators above the tubesheet. As the nitrogen bubble expands, it forces the water in the steam generator to rise at a high velocity to dislodge deposits on the tube support plates.

In a related technology called Pulse Detonation Technology, investigated for use in coal-fired boilers, a combustion source is used to create the shockwave that provides sufficient mechanical energy and thermal shock to dislodge slag from gas contact surfaces.

Waterlancing, also known as water jetting, hydrolancing and sludge lancing employs high-pressure water to dislodge sludge deposits and transport them out of the steam generator tube bundle. Currently the process is used

mainly for tubesheet deposits due to accessibility and steam generator design issues (i.e. steam generator tube bundles can have square pitch or triangular pitch designs). Water lance systems have not achieved much success in removing collars. Only limited success was reported with a 10,000-psig system. However, even with this system, only small portions of the collars were removed.

Certain U.S. patents teach various pressure pulse technologies or thermal stress for sludge removal.

U.S. Patent No. 4,655,846 teaches the use of intermittent pressure pulse technology to remove sludge deposits from steam generator's heat exchanger at various elevations including the bottom thereof. There is no teaching of an accompanying thermal stress induced sludge removal technology.

U.S. Patent No. 5,429,077 teaches the removal of deposits from a heat exchanger using thermal stress induced by adding a fluid of a first temperature to a fluid at a second temperature to induce a mechanical stress and tube vibration dislodging the deposit.

A careful review of the above prior art shows that the use of thermal stress and pressure pulses are individually suggested for sludge removal from heat exchanger elements; however, a method of using a combination of thermal stress and pressure pulses to remove sludge deposits from heat exchanger elements is not disclosed in the references. Furthermore, there is no hint of using such a combination.

SUMMARY OF THE INVENTION

The present invention solves the problems associated with prior art devices as well as others by providing a method of removing sludge deposits from steam generator/boiler boiler tube support plates using a combination of thermal stress and intermittent pressure pulses identified as "Steam Generator Thermal Venting". This method involves the steps of:

1. Identifying the location(s) of the sludge covered tube support plates (TSP);
2. Draining the water level to just above the identified TSP;
3. Allowing the pressure inside the component to increase to a designated level;
4. Venting the boiler/steam generator to induce boiling thus creating both thermal and mechanical stress in the sludge;
5. Draining the boiler to the next sludge clogged TSP; and
6. Repeating steps 2-5.

In view of the foregoing it will be seen that one aspect of the present invention is to provide an efficient method of removing "collar deposits" from tubesheet areas and/or to remove the sludge from the tube support plate and tube surfaces above the tubesheet.

Another aspect is to provide a method of cleaning tube support plates comprising the use of thermal stress and intermittent pressure pulses to clean tube support plates during boiler/steam generator outage times, normally during shut down cycles without the application of external heat or pressure sources.

These and other aspects will be more fully understood from a review of the following description of the preferred embodiment when considered along with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings wherein:

Fig. 1 is a cut away perspective view of a steam generator showing the tube support plates located therein; and

Fig. 2 shows a typical steam generator tube bundle configurations.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention discloses a method of removing sludge deposits from steam generator tube support plates and tubesheets using a unique process of thermal venting and pressure pulse application called "Steam Generator Thermal Venting". This process may be especially useful in removing very hard "collar deposits" from tube support plates and involves the following steps:

1. Identifying the location(s) of the sludge covered tube support plates TSP or collar;
2. Draining the water level to just above the identified TSP or collar;
3. Allowing the pressure inside the component to increase to a designated level;
4. Venting the boiler/steam generator to induce boiling thus creating both thermal and mechanical stress in the sludge;
5. Draining the boiler to the next sludge clogged TSP; and
6. Repeating steps 2-5.

It should be noted that this process uses no external heat source to heat the water and instead uses the system heat (typically in excess of 250 degrees Fahrenheit.). Also, no external device is used to apply pressure pulses used in this cleaning process. Rather, the boiling caused by the venting process provides the pressure pulses. The number of vents and the duration of venting are based on calculations to determine the desired depth of boiling.

Referring now to the drawings, Fig. 1 shows a typical recirculating steam generator (A) including the tubesheet (B) from which a series of boiler tubes (C) extending through a series of tube support plates (D) enclosed within an outer shell (E). In cleaning the TSP of the boiler thermal venting of the generator (A) is

done anytime during an outage, normally during steam generator draindown at the start of an outage. The number of vents and the locations at which venting is performed depends on where sludge and deposits are located as determined by Eddy Current Analysis, Secondary Side Inspection or other analytical techniques. Nominally the water levels above the tube support plates vary from zero to thirty-six inches above then targeted tube support plate. Depending on the rate at which steam is removes from the steam generator, the effect of the boiling could be from the top of the tube bundle to the top of the tubesheet. Desired levels would be determined by calculation.

The "Steam Generating Thermal Venting" procedure would be applied in the same manner for all instances of application regardless of the deposit thickness or location. In cases, for which it was determined that a particular TSP was laden with deposit, the steam generator would be vented through the atmospheric dump, or steam bypass valves after they were drained to just above the TSP in question. Boiling of the bulk liquid is then initiated and continues for a time sufficient to cause boiling to a desired depth, typically the full depth of the area of concern at a temperature that can vary based on calculations. The first vent could be followed by subsequent vents at lower TSPs to ensure that disrupted deposits were flushed down to the tubesheet or out with the draining water.

It will be understood that certain modifications, additions and details have been deleted herein for the sake of conciseness and readability but that they are fully intended to fall within the scope of the following claims.

CLAIMS

1. A method of removing sludge deposits from a steam generator comprising the steps of: